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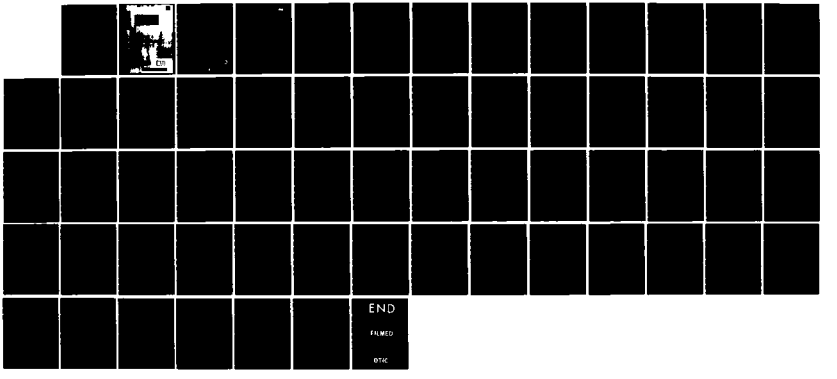

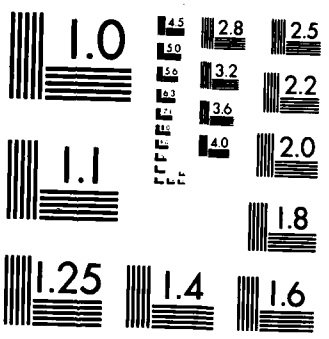

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MILITARY VERSUS PRIVATE SECTOR CONSTRUCTION COSTS

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March 1985

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Joseph S. Domin

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Executive Summary

MILITARY VERSUS PRIVATE SECTOR CONSTRUCTION COSTS

Major contracts for military construction (MILCON) exceed four billion dollars per year. The Department of Defense (DoD) has questioned whether their costs of construction are in line with those in the private sector for similar projects. We conclude that they are.

The DoD has 27 facility categories. Six of them account for a major portion of the MILCON budget and are facilities frequently cited to have costs higher than similar private sector projects. In five of the six -- physical fitness centers, general-purpose warehouses, barracks, wheeled vehicle maintenance shops, and family housing units -- DoD MILCON costs are generally equivalent to those in the private sector and less than those in other government agencies.

In the sixth category, child care centers, MILCON costs are higher. In the two DoD child care centers we examined in detail, design features such as rubber-surfaced playgrounds, atriums, and ornate architecture added significantly to costs. Reexamining the design criteria and more closely reviewing the designs of proposed facilities should bring DoD child care center costs in line.

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COMPARISON OF DOD, OTHER GOVERNMENT, AND PRIVATE SECTOR COSTS

INTRODUCTION

Each year, the Department of Defense (DoD) contracts for more than 1000 major military construction (MILCON) projects costing over $4 billion.

Managers and reviewers of this program frequently ask, "Does the DoD pay more for its construction than other owners?" The answer to this question is obtained by comparing the construction costs for the DoD with those of other government agencies and the private sector. We limit our investigation to six facility categories that represent a significant share of the MILCON appropriations and are perceived to have a higher cost than similar private sector projects: physical fitness centers, general-purpose warehouses, barracks, wheeled vehicle maintenance shops, child care centers, and family housing. The construction costs for these facility categories are compared to projects built by other government agencies and the private sector. We compare actual costs of completed construction projects reported in several large data files. The costs are adjusted to the same year and average U.S. prices.

The scope of this study does not include an assessment of the appropriateness of the individual project specifications to owner needs and requirements. Thus, the issue of "over or under specification" is not part of the analysis.

DOES THE DOD PAY MORE?

In five of the six facility categories we examined, the DoD unit construction costs compare favorably with those paid by its government and private sector counterparts. Only for child care centers does it appear that the DoD is paying more. The cost differential for child care centers is due

primarily to design differences. In two DoD child care facilities that we examined, design embellishments that do little to enhance the capabilities of the facility added a significant increment to the cost. While this problem may not exist DoD-wide, it does point up the need for further evaluation of child care center design criteria with an emphasis on standardization.

The DoD costs for wheeled vehicle maintenance shops also appear, at first glance, to be higher than other government agencies and private sector costs. The difference, it turns out, is mainly a definitional problem. The DoD wheeled vehicle maintenance category contains a number of heavy equipment maintenance, track maintenance, and rebuild facilities that are not common to the private sector facilities used in the comparison. The DoD data for this category included an engineer group shop, an engineer battalion shop, four tracked vehicle repair facilities, and a depot level track vehicle repair facility. When those higher-cost facilities are eliminated, the costs for wheeled vehicle maintenance shops compare favorably with those of the private sector and other government agencies.

FACILITY COMPARISONS

We use four data sources to compare actual DoD construction costs with actual costs of other government agencies and private sector owners. For the DoD, our data is the sample of FY 1980 to FY 1984 construction projects used by the Deputy Assistant Secretary of Defense (Installations) to prepare the DoD report "Unit Costs for Common Department of Defense Facilities." These are the actual reported construction costs adjusted by the Tri-Service Committee for FY86 for the projects contained in the sample. A description of the DoD construction cost data is in Appendix A.

For other government agencies and private sector owners, our data is taken from two commercial actual cost data bases: R.S. Means Company, Inc.

and F.W. Dodge Company, now affiliated with Data Resources Incorporated (DRI). These two companies maintain the largest and most widely used data bases of construction cost information in the United States. The costs for these data bases were adjusted to FY86 levels using MCP Index (DACA-BUR) with projections based on PBC Memo No. 84-12 and Office of the Assistant Secretary of Defense Comptroller's 29 June 1984 memorandum. A description of these two data bases is included in Appendix B.

Our fourth data source is the actual construction costs for specific private sector examples of projects in the Washington, D.C., area. The data for these projects are presented in Appendix D.

The data bases used in our comparisons encompass a wide variety of projects that exhibit all types of construction criteria. Some projects at the low end of the cost range for each category are not representative of DoD construction because of design life and material quality differences. Similarly, some projects at the high end of each category range -- outliers -- are not representative of the remainder of the range. Both of these factors tend to distort range comparisons. One method for minimizing the impact of these distorting factors is to reconstruct the ranges and show only the values between the 25th and 75th percentile. That approach tends to eliminate outliers and to screen out short-design-life, low-quality projects. We use the 25th/75th percentile project range, e.g., that portion of the total cost range within which 50 percent of the projects reside, in all comparisons to provide a more accurate representation of the unit cost tendency of the category.

The specific private sector examples provide a reference point for the Means and Dodge private sector cost ranges. The selected examples have construction standards very similar to those experienced in DoD projects. They

should represent the point in the private sector cost range where construction criteria are roughly comparable to those of the DoD. These examples, however, are single, randomly selected points and are not intended to represent expected or ideal costs. When used in conjunction with the Means and Dodge cost ranges, they provide useful information and assist in interpreting the private sector cost ranges.

Figures 1 through 12 present graphic comparisons of the unit costs (cost per square foot) for the six facility categories. Two figures are shown for each category. The first depicts the mean, median, and cost range for the DoD; the medians and cost ranges for other federal, state, and local governments and the private sector as represented by R.S. Means and F.W. Dodge cost data; and the unit cost for the private sector example. The second figure in each category shows the same DoD cost data and a break out of the F.W. Dodge cost data by federal, state and local government, and private owners.

Fitness Centers

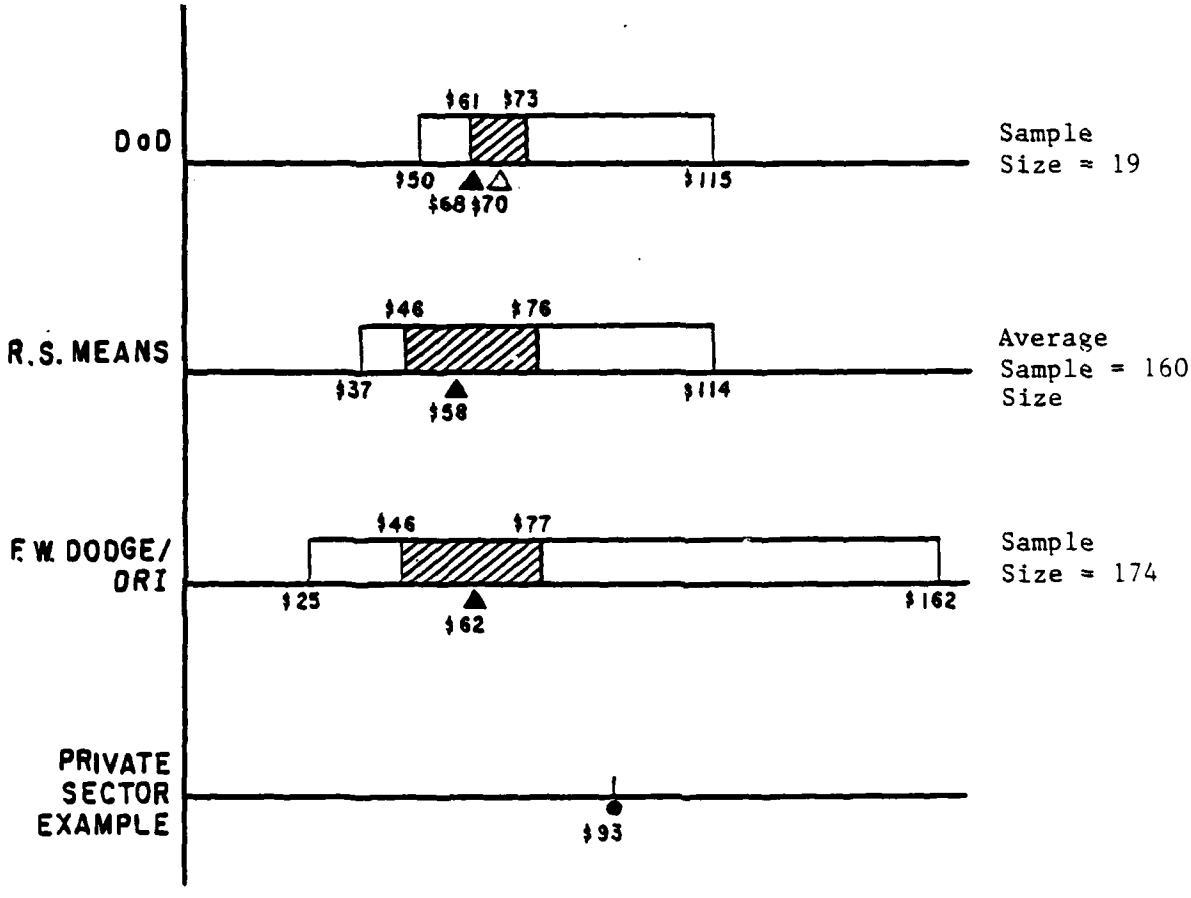
DoD fitness centers are directly comparable to those built by other owners. The types of structures and design criteria in this category are generally the same. The DoD cost range compares favorably to the Means and Dodge cost ranges. The DoD median cost is approximately 13 percent higher than the Means or Dodge medians and 26 percent lower than the federal median. The cost differentials are not statistically significant indicating that unit cost parity exists for this facility category.

General-Purpose Warehouses

Some minor comparability problems exist with warehouses, but, since they have little effect on the DoD data, we disregarded them. The DoD cost range compares favorably to the Means and Dodge cost ranges. The DoD median is approximately 11 percent lower than the Means and Dodge medians and

FIGURE 1. COST RANGE COMPARISON
FITNESS CENTERS

(All Costs are April 1986 Dollars per Square Foot)



LEGEND

= 25th TO 75th PERCENTILE RANGE

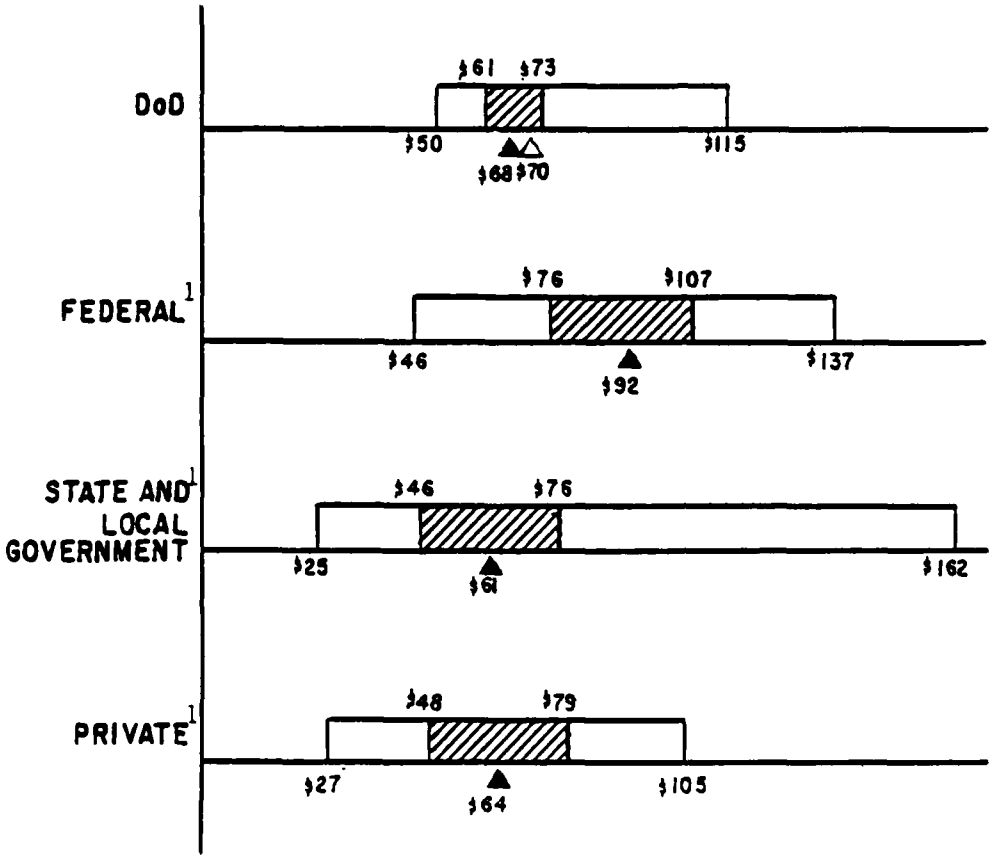
▲ = MEDIAN COST

△ = MEAN COST

● = SINGLE DATA POINT

FIGURE 2. COST RANGE COMPARISON BY OWNER
FITNESS CENTERS

(All Costs are April 1986 Dollars per Square Foot)



LEGEND

▨ = 25th TO 75th PERCENTILE RANGE

▲ = MEDIAN COST

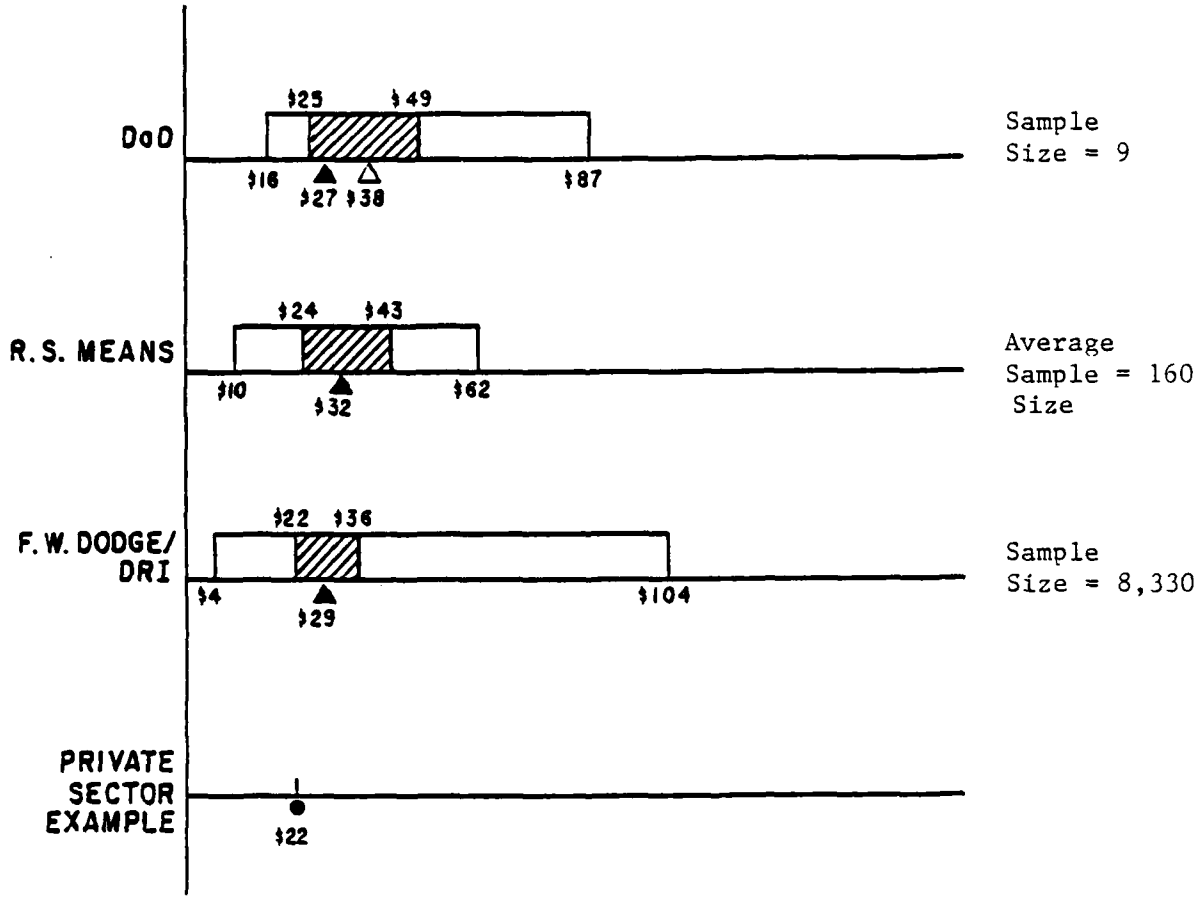
△ = MEAN COST

● = SINGLE DATA POINT

[1]Source is F.W. Dodge/DRI. Federal includes DoD.

FIGURE 3. COST RANGE COMPARISON
GENERAL PURPOSE WAREHOUSES

(All Costs are April 1986 Dollars per Square Foot)



LEGEND

▨ = 25th TO 75th PERCENTILE RANGE

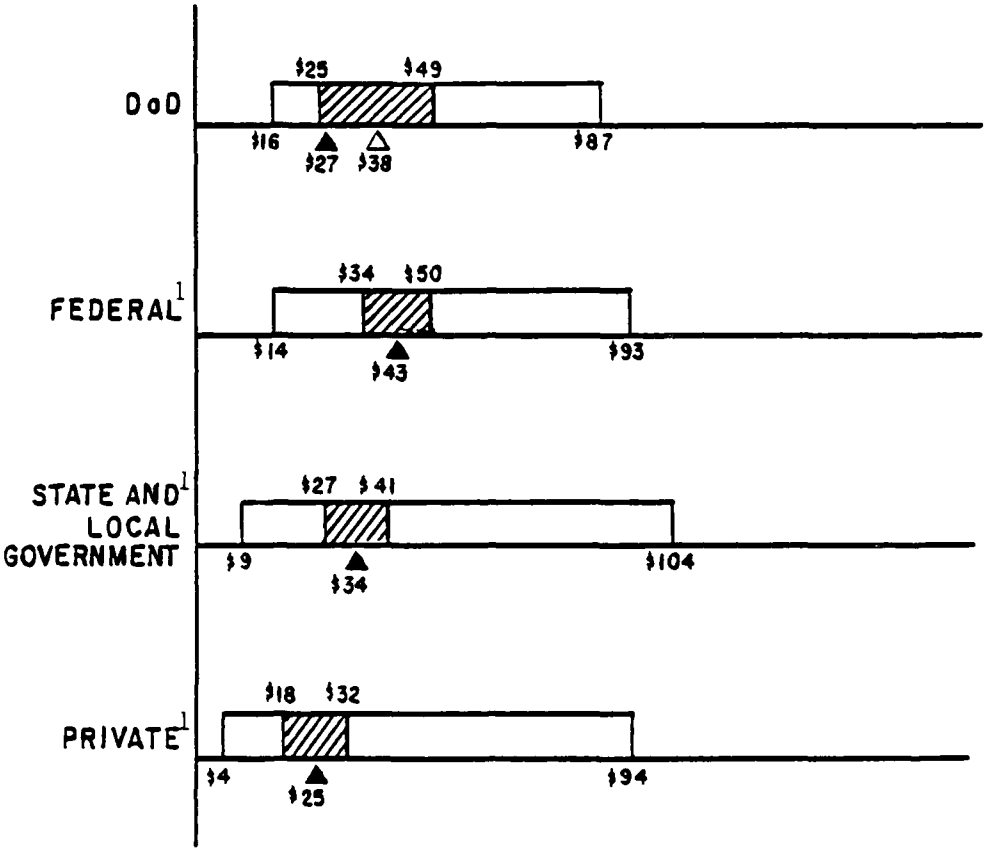
▲ = MEDIAN COST

△ = MEAN COST

● = SINGLE DATA POINT

FIGURE 4. COST RANGE COMPARISON BY OWNER
GENERAL PURPOSE WAREHOUSES

(All Costs are April 1986 Dollars per Square Foot)



LEGEND

▨ = 25th TO 75th PERCENTILE RANGE

▲ = MEDIAN COST

△ = MEAN COST

● = SINGLE DATA POINT

[1]Source is F.W. Dodge/DRI. Federal includes DoD.

TABLE A-2. COMPARATIVE INFLATION FACTORS

MONTH/ YEAR	INFLATION FACTORS		MONTH/ YEAR	INFLATION FACTORS
	ENR	MEANS 30-CITY AVERAGE		OSD COMPTROLLER
Jan 1980	1.266	1.327	April, 1980	1.302
Jan 1981	1.192	1.219	April, 1981	1.177
Jan 1982	1.100	1.117	April, 1982	1.094
Jan 1983	1.039	1.030	April, 1983	1.043
Jan 1984	1.000	1.000	April, 1984	1.000
July 1984	1.007			
5-Year Average	1.119	1.139		1.123
			April, 1985	1.049
			April, 1986	1.097
			April, 1987	1.144

We believe the escalation factors for converting to January 1984 price levels are accurate to within 2 percent (one standard deviation) when applied to a data base with projects distributed over 5 years. Only the OSD (Comptroller) forecasts future inflation for planning purposes. Those estimates affect programmed and budgeted amounts for military construction, but are not vital to the comparison of military to commercial project costs since the estimates we use for future inflation are the same in both cases.

GEOGRAPHIC LOCATION

The DoD facilities cost data were adjusted to a base of 1.00 using old area cost factors for FY 1980 and FY 1981 and weighted material labor indices for FY 1982 through FY 1984. In calculating the old factors, construction prices in the Washington, D.C., area were established as the point of reference with a location factor of 1.00. The new factors establish a 144-city

iscussed below and, where appropriate, are compared to those used by a ommercial firm and, in the case of inflation rates, to those used by the OSD Comptroller). The statistical characteristics of the project cost data base or selected facility categories also are presented in this section.

NFLATION ADJUSTMENT

Inflation factors were applied to costs for DoD projects with bid dates rom FY 1980 through FY 1984. The historical DoD inflation factors are based n the index published in the Engineering News Record (ENR) over the period rom October 1979 to July 1984. Estimates of future inflation out to pril 1986 and 1987 were obtained from the OSD Comptroller's office.

The historical inflation factors from the ENR used in developing unit ost factors agree closely with similar indices developed by the R. S. Means ompany and the OSD (Comptroller). Table A-2 summarizes these factors and lso shows a 5-year average factor that would be the net adjustment to average roject cost if the dollar value of projects were distributed equally in each f the 5 years from FY 1980 to FY 1984. The 5-year average factor based on he ENR index is 2 percent less than the comparable average from Means and .4 percent less than the OSD 5-year average factor. All three indices are ased on weighted labor-material price indices rather than on observed ncreases in finished project costs. The latter approach would account for hanges in productivity resulting from the use of new construction equipment, utomation, electronic data processing, and new materials. However, roductivity changes should not significantly affect the inflation factors sed since the data base consists only of projects constructed since FY 1980. roductivity change over that short period would not significantly degrade the ccuracy of input-oriented price indices.

TABLE A-1. DOD CONSTRUCTION DATA FOR SELECTED FACILITIES TYPES

DATA ELEMENT	UNIT OF MEASURE	PHYSICAL FITNESS CENTERS	GENERAL PURPOSE WAREHOUSES	BARRACKS AND DORMITORIES	WHEELED VEHICLE MAINTENANCE SHOPS	CHILD CARE CENTERS	FAMILY HOUSING UNITS
Unit Costs	$ per s.f.	$70.00	$38.00	$55.00	$69.00	$80.00	$46.00[b]
Typical Size	gross s.f.	20,000	40,000	N/A[a]	30,000	8,000	N/A
Sample Size	# of projects	19	9	56	19	17	N/A
Standard Deviation	$ per s.f.	$14.50	$23.20	$12.60	$32.50	$24.20	N/A
Relative Standard Deviation	% of unit costs	21	61	23	47	30	N/A
Minimum Cost	$ per s.f.	$49.50	$15.80	$30.40	$23.30	$50.30	N/A
Maximum Cost	$ per s.f.	$115.30	$87.30	$92.80	$138.60	$149.60	N/A

[a]A size adjustment factor is not used for barracks and dormitories.

[b]The unit cost for family housing is based on prior years' values and legislative guidance.

APPENDIX A

DOD CONSTRUCTION COST DATA

The Deputy Assistant Secretary of Defense (Installations) periodically provides unit cost per square foot factors by facility category to the Military Departments and Defense agencies. The most recent factors are being used by OSD to review the proposed FY 1986 construction program and are provided as guidance for making initial estimates for FY 1987 programs.[1] The cost per square foot factors are developed by the Tri-Service Committee using bid data from all the Services over 5 years (FY 1980 through FY 1984).

DOD CONSTRUCTION COST DATA BASE

The DoD construction cost data base for six selected facilities is summarized in Table A-1. Unit costs are computed as follows:

$$\text{Unit Costs} = \frac{(\text{Original Bid or Final Cost} \times \text{Inflation Factor})}{(\text{Location Factor} \times \text{Size Factor})}$$

The resultant unit costs are the cost per square foot for a typical size facility at the average price levels in 144 cities at estimated April 1, 1986, price levels. Multiplying this figure by appropriate factors results in estimates tailored to different locations, sizes, and time periods.

In this study, we compared the DoD unit costs to comparable costs for other government and private facilities. The DoD unit costs are average costs per square foot by facility category based on a sample of completed project costs. Three adjustments are made to the original project cost data to arrive at the cost per square foot factors published by OSD. The adjustments are for inflation, location, and project size. The adjustment factors used are

[1] "Unit Costs for Common Department of Defense Facilities," Deputy Assistant Secretary of Defense (Installations) Memorandum, 10 August 1984.

Child Care Centers

Child care centers presented the largest comparability problem of all the facility categories examined. Since neither Means nor Dodge have data on child care centers, we selected surrogate facilities from their available data. The Means surrogate was religious education centers, and the Dodge surrogate was special schools. For these comparisons, the DoD cost range is higher than the Means and Dodge cost ranges. The DoD median cost is 43 and 31 percent higher than the Means and Dodge medians, respectively, and 18 percent lower than the federal median. These differences are statistically significant. As another check, we examined two DoD child care centers in detail and found design differences between them and the private sector example. The DoD centers had significant design embellishments that added to the cost. Examples of these embellishments are atriums, rubber surfaced playgrounds, and ornate architecture. It appears that DoD unit costs for this category are higher than those of similar private sector structures.

Family Housing

The sixth category examined was family housing units, and it presents virtually no comparability problems. Most DoD family housing is built to the same standards used in the private sector. Since the DoD does not maintain historical data on family housing construction costs, the DoD unit cost factor is used for comparisons. The R.S. Means Company does not maintain data on a residential housing category, but the F.W. Dodge Company has data on a three- and four-unit apartment category that is comparable. The DoD unit cost factor fell within the Dodge cost range and that of the private sector. The DoD unit cost factor was 9 percent higher than the Dodge median and 29 percent lower than the federal median. Available information indicates that DoD unit costs for this facility category are approximately equal to those experienced by the private sector.

37 percent lower than the federal median. All factors indicate that cost parity exists for this facility category.

Barracks/Dormitories

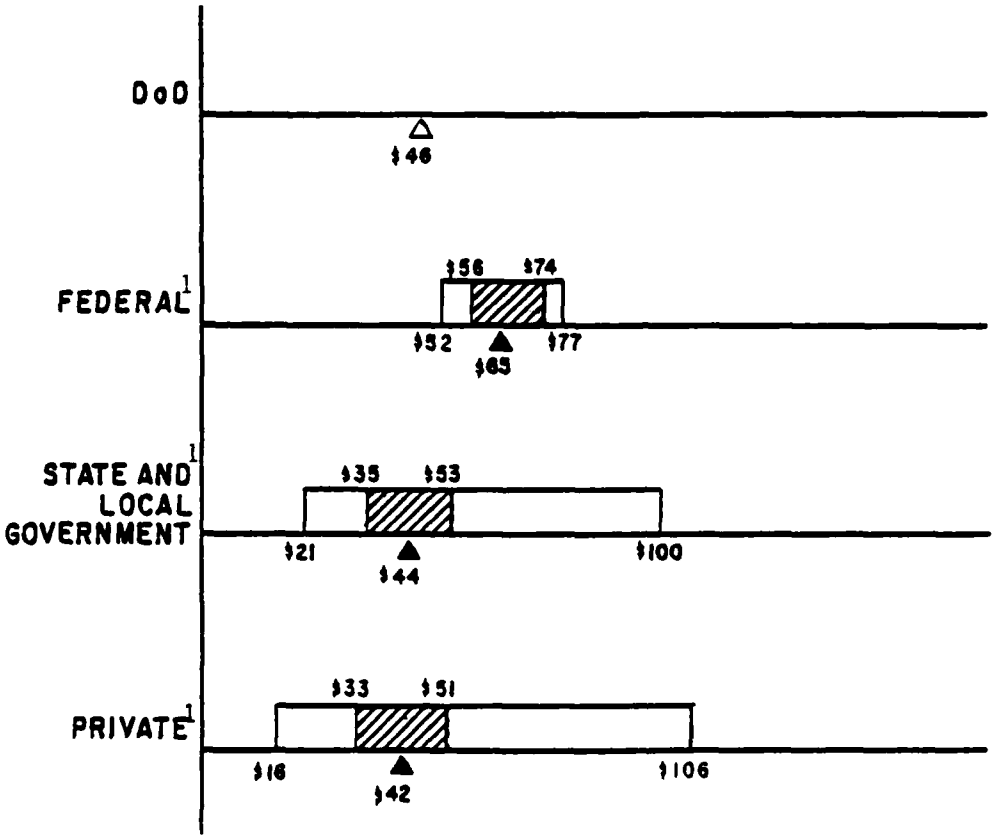
The design criteria for DoD barracks/dormitories are very comparable to the criteria for dormitories built by other owners. The DoD cost range is less than all other ranges. Similarly, the DoD median is approximately 14 percent lower than the Means and Dodge medians, and 31 percent lower than the federal median. The lower DoD cost is partially due to the previously legislated unit cost for DoD barracks construction. To stay within the statutory limit, contractors often shift costs to bid items in their proposal that are not covered by the statute. With the statutory limit removed, DoD barracks construction costs can be expected to rise in the future. Based on current available data, DoD unit costs for this facility category are lower than those experienced by all other owners.

Wheeled Vehicle Maintenance Shops

DoD wheeled vehicle maintenance shops are not directly comparable to the facilities included in Means and Dodge. The main problem is that the DoD category includes a significant number of higher-cost tracked vehicle maintenance shops, heavy equipment maintenance shops, and rebuild facilities. The DoD data for this category included an engineer group shop, an engineer battalion shop, four tracked vehicle repair facilities, and a depot level track vehicle repair facility. These facilities distort the DoD cost range and make comparisons less valid. With these facilities included, the DoD cost ranges are higher than both Means and Dodge cost ranges. With nonrepresentative facilities removed from the DoD sample, the adjusted DoD range compares favorably with those for Means and Dodge.

FIGURE 12. COST RANGE COMPARISON BY OWNER FAMILY HOUSING

(All Costs are April 1986 Dollars per Square Foot)



LEGEND

▨ = 25th TO 75th PERCENTILE RANGE

▲ = MEDIAN COST

△ = MEAN COST

● = SINGLE DATA POINT

[1]Source is F.W. Dodge/DRI. Federal includes DoD.

FIGURE 11. COST RANGE COMPARISON
FAMILY HOUSING

(All Costs are April 1986 Dollars per Square Foot)

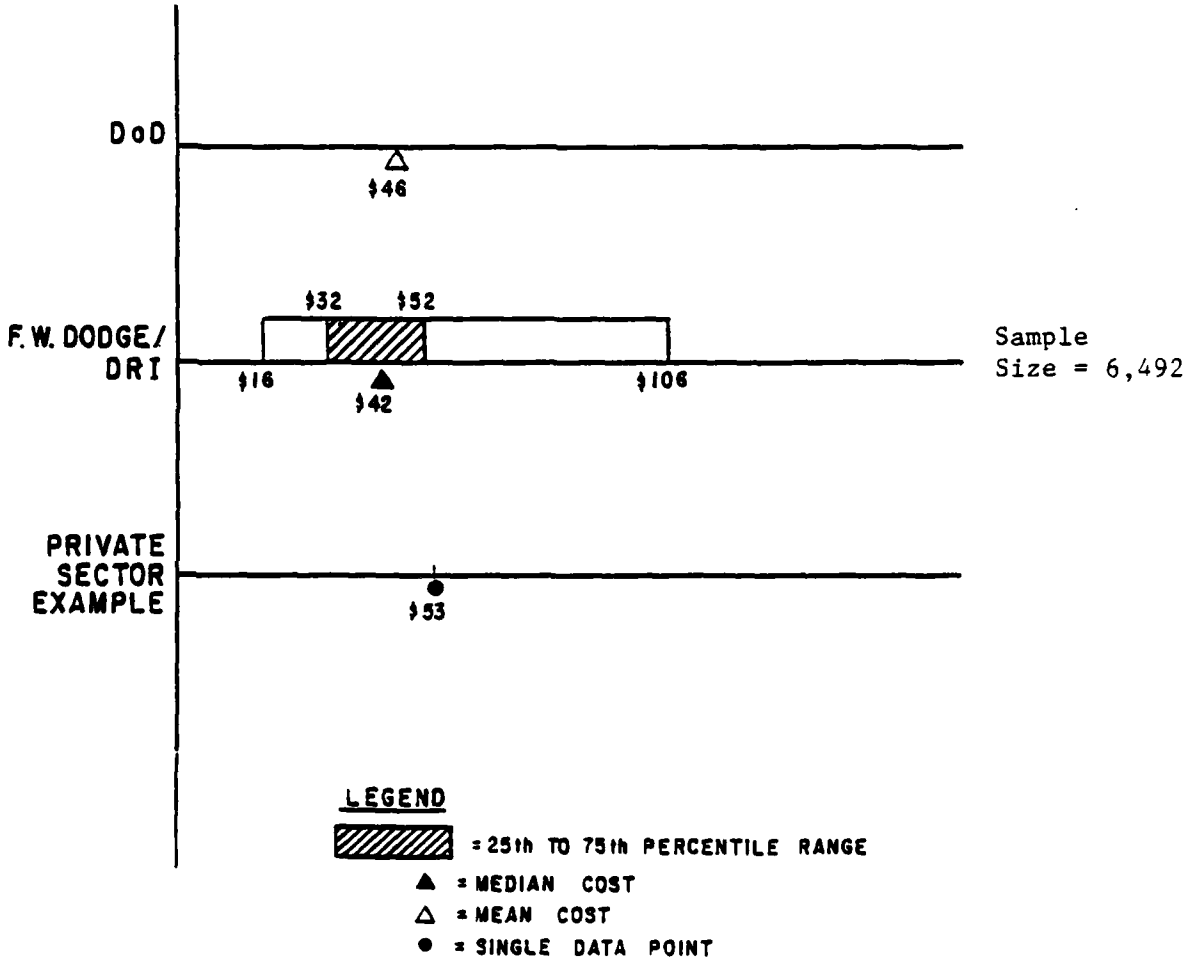
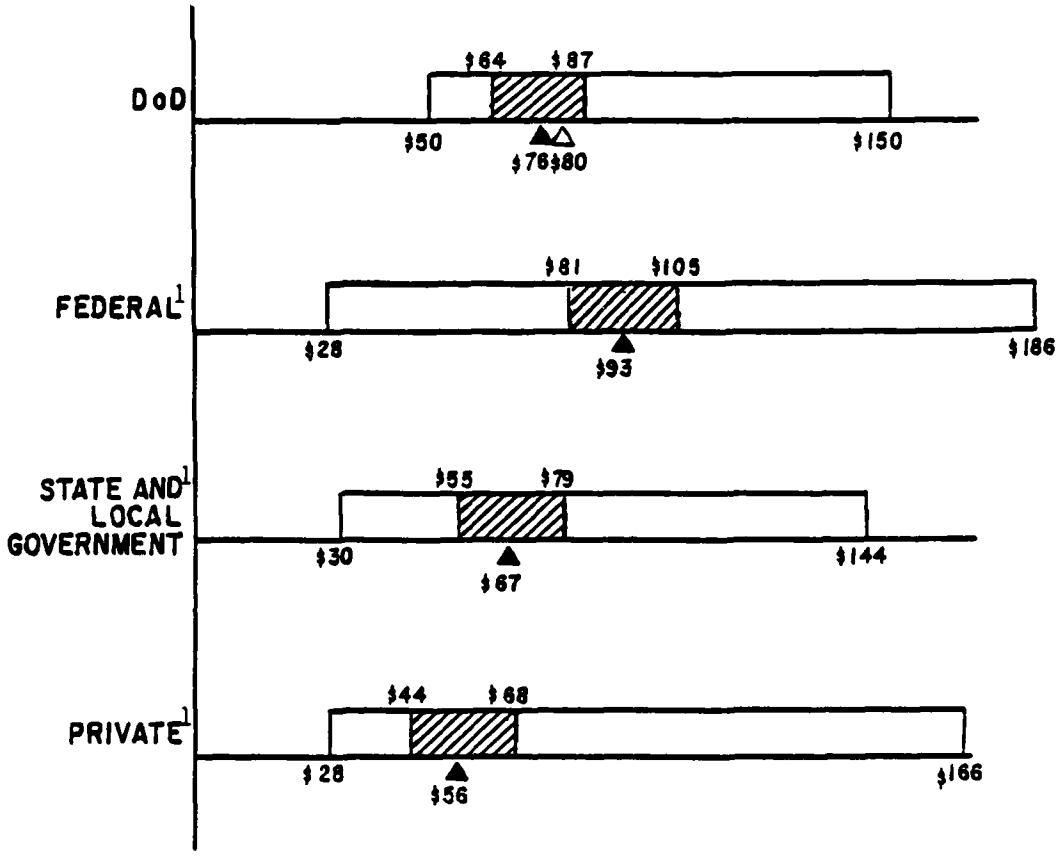


FIGURE 10. COST RANGE COMPARISON BY OWNER
CHILD CARE CENTERS

(All Costs are April 1986 Dollars per Square Foot)



LEGEND

= 25th TO 75th PERCENTILE RANGE

▲ = MEDIAN COST

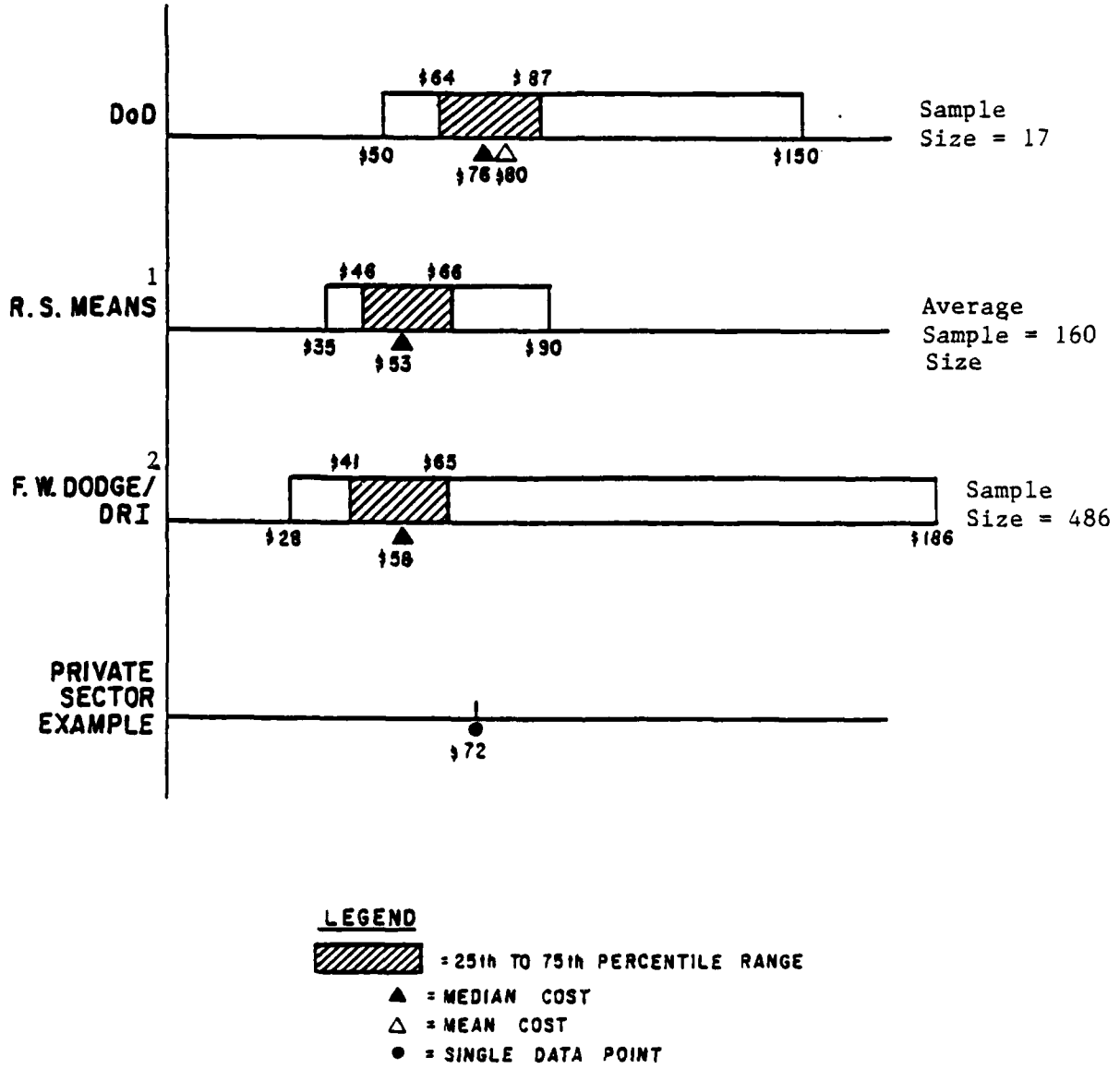
△ = MEAN COST

● = SINGLE DATA POINT

[1]F.W. Dodge/DRI special schools category. Federal includes DoD.

FIGURE 9. COST RANGE COMPARISON
CHILD CARE CENTERS

(All Costs are April 1986 Dollars per Square Foot)

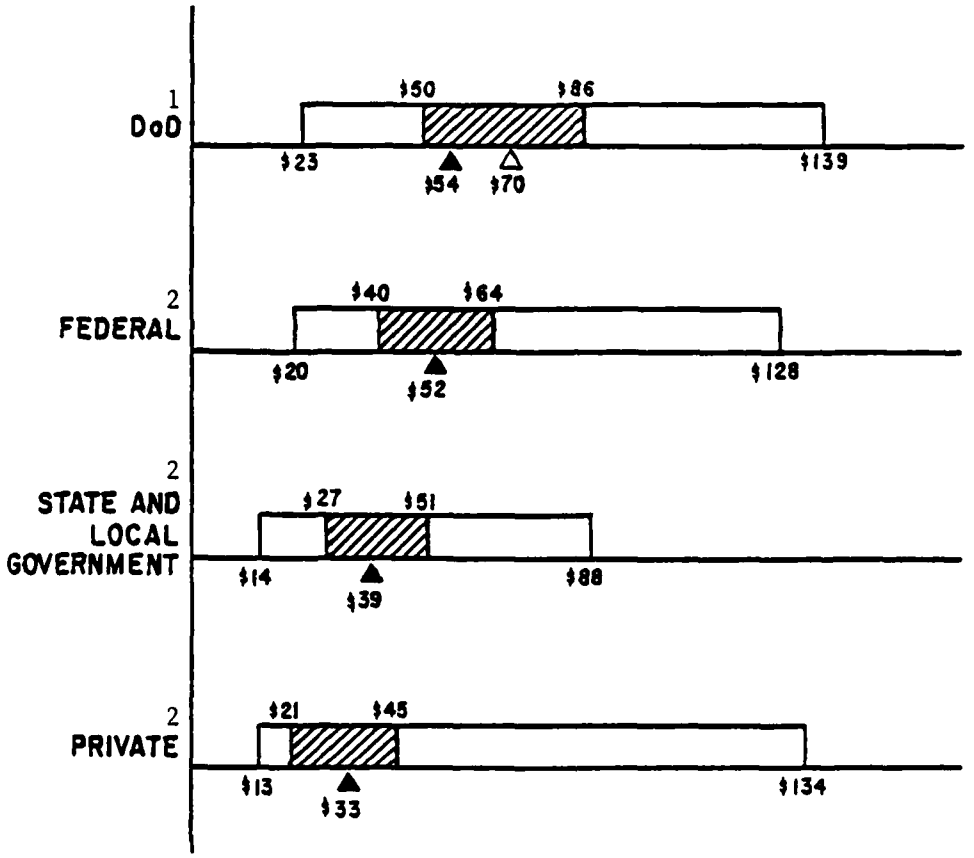


[1]No Means category for child care centers exists. Religious education centers are used as a surrogate.

[2]No Dodge category for child care centers exists. Special schools are used as a surrogate.

FIGURE 8. COST RANGE COMPARISON BY OWNER
WHEELED VEHICLE MAINTENANCE SHOPS

(All Costs are April 1986 Dollars per Square Foot)



LEGEND

▨ = 25th TO 75th PERCENTILE RANGE
▲ = MEDIAN COST
△ = MEAN COST
● = SINGLE DATA POINT

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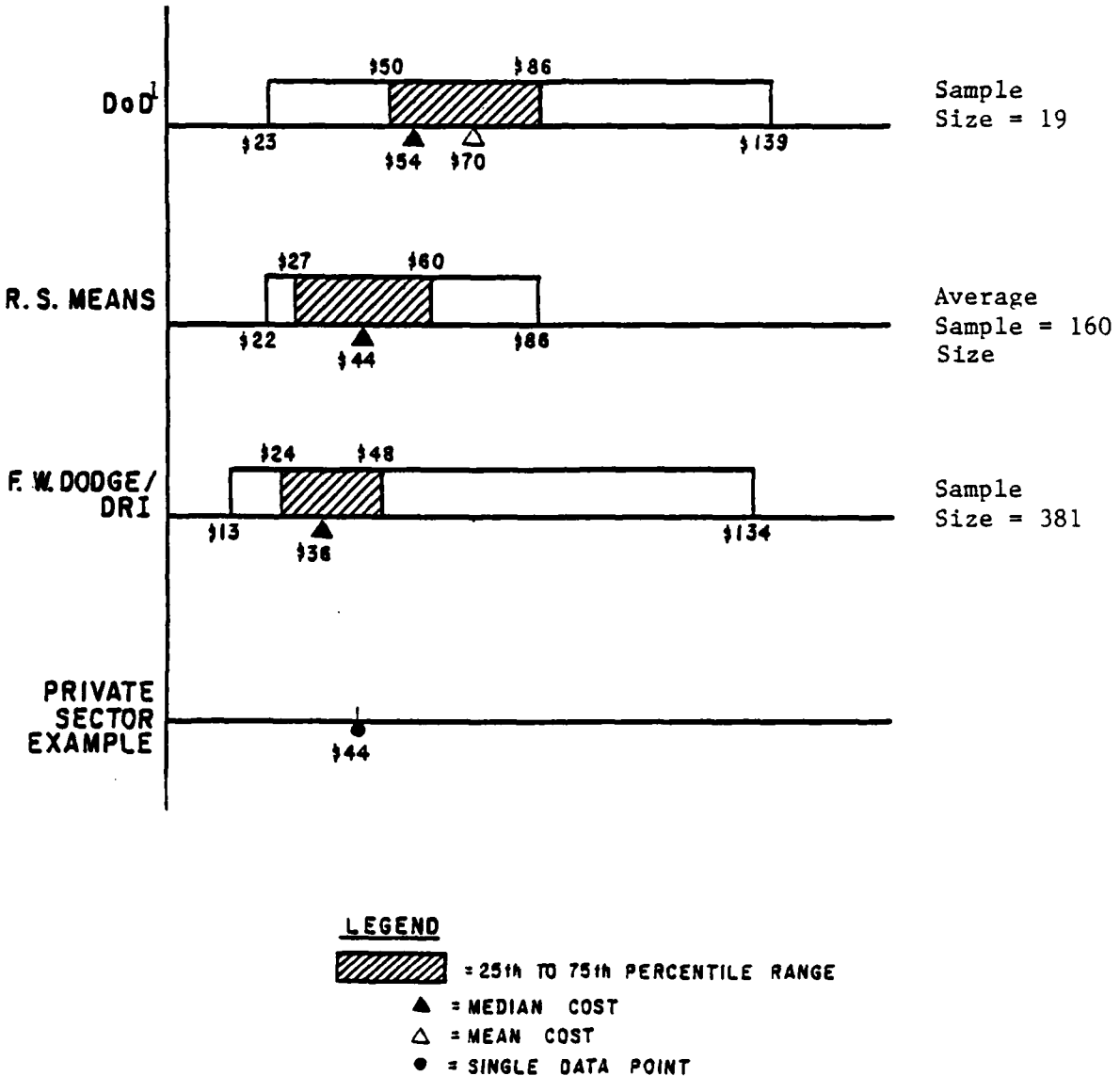
[1]DoD category contains nonrepresentative data points. The adjusted range with nonrepresentative data points removed is $23 to $97 with a mean cost of $53. The adjusted 25th and 75th percentiles are $43 and $53 respectively, and the adjusted median cost is $52. See page 17.

[2]Source is F.W. Dodge/DRI. Federal includes the DoD.

FIGURE 7. COST RANGE COMPARISON
WHEELED VEHICLE MAINTENANCE SHOPS

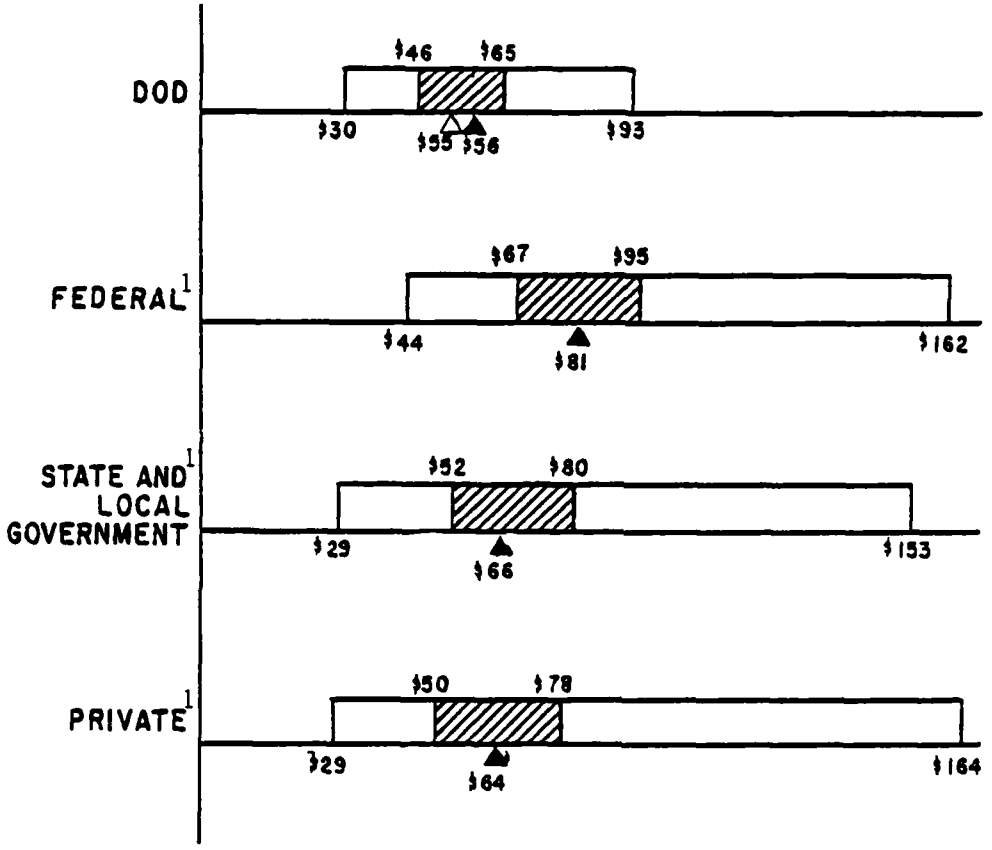
(All Costs are April 1986 Dollars per Square Foot)



[1]DoD category contains nonrepresentative data points. The adjusted range with nonrepresentative data points removed is $23 to $97 with a mean cost of $53. The adjusted 25th and 75th percentiles are $43 and $53 respectively, and the adjusted median cost is $52. See page 17.

FIGURE 6. COST RANGE COMPARISON BY OWNER
BARRACKS/DORMITORIES

(All Costs are April 1986 Dollars per Square Foot)



LEGEND

= 25th TO 75th PERCENTILE RANGE

▲ = MEDIAN COST

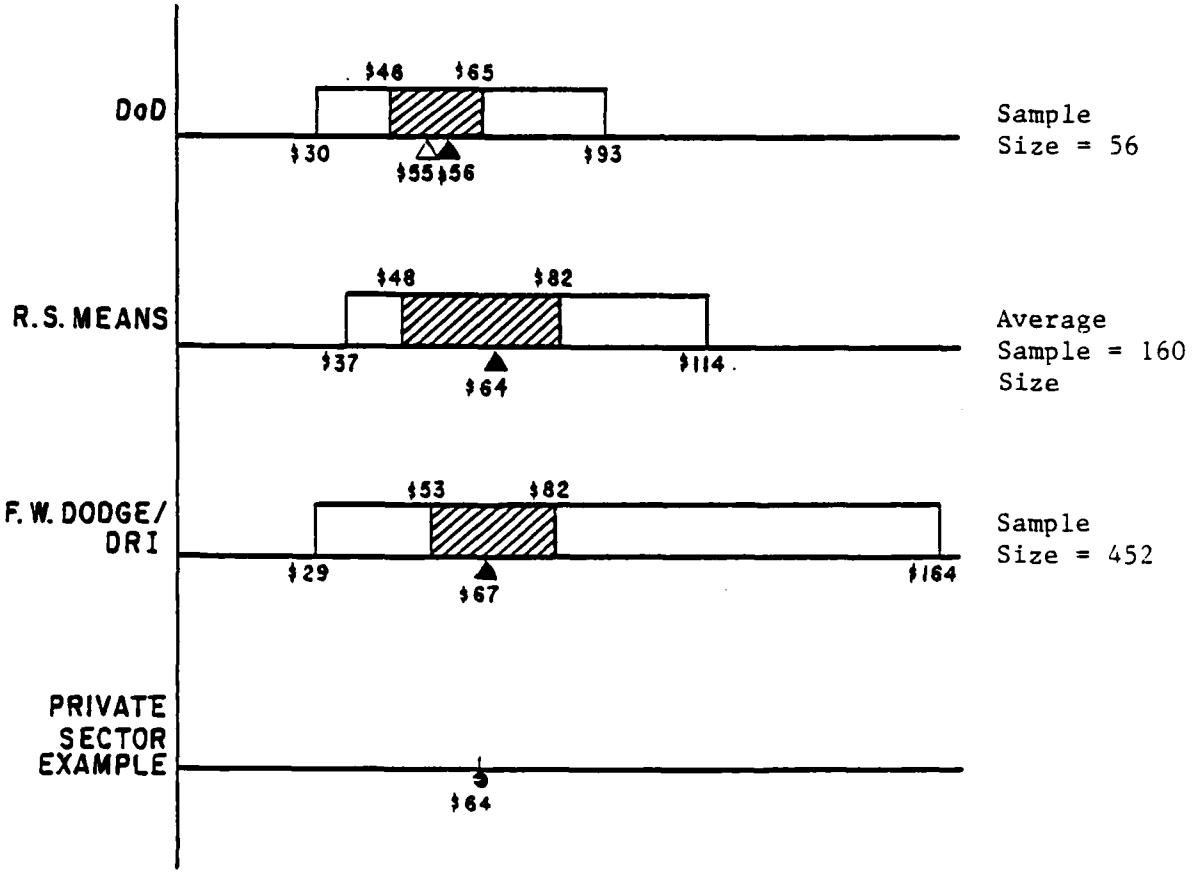
△ = MEAN COST

● = SINGLE DATA POINT

[1] Source is F.W. Dodge/DRI. Federal includes DoD.

FIGURE 5. COST RANGE COMPARISON
BARRACKS/DORMITORIES

(All Costs are April 1986 Dollars per Square Foot)



average as the point of reference, and the latest factor[2] for Washington, D.C., is 1.08. This shift in the base could cause the FY 1980 and FY 1981 projects to be understated by as much as 8 percent because of the shift in the reference point to a lower base. The unit cost factors for the facility categories we evaluated would, at most, be 2.5 percent greater if the 144-city average was used consistently throughout all 5 years in the data base.

A comparison of the new DoD location factors to the location factors for commercial construction from "Means Square Foot Costs" for 1984 for a sample of 126 cities reveals that, on average, the Means location factor is 4.8 percent higher than that of the DoD. The Means reference point is a 30-city average, whereas the DoD reference point is a 144-city average containing more cities with lower location factors. Use of either location factor consistently to account for intercity cost differences is acceptable. After the data are adjusted for the difference in the reference point, differences still exist in location factors for individual cities. The standard deviation of the difference between R.S. Means and DoD location factors based on the sample of 126 cities is 0.07. Based on this comparison, we assume that the estimates of location factors are accurate to within 7 percent (one standard deviation).

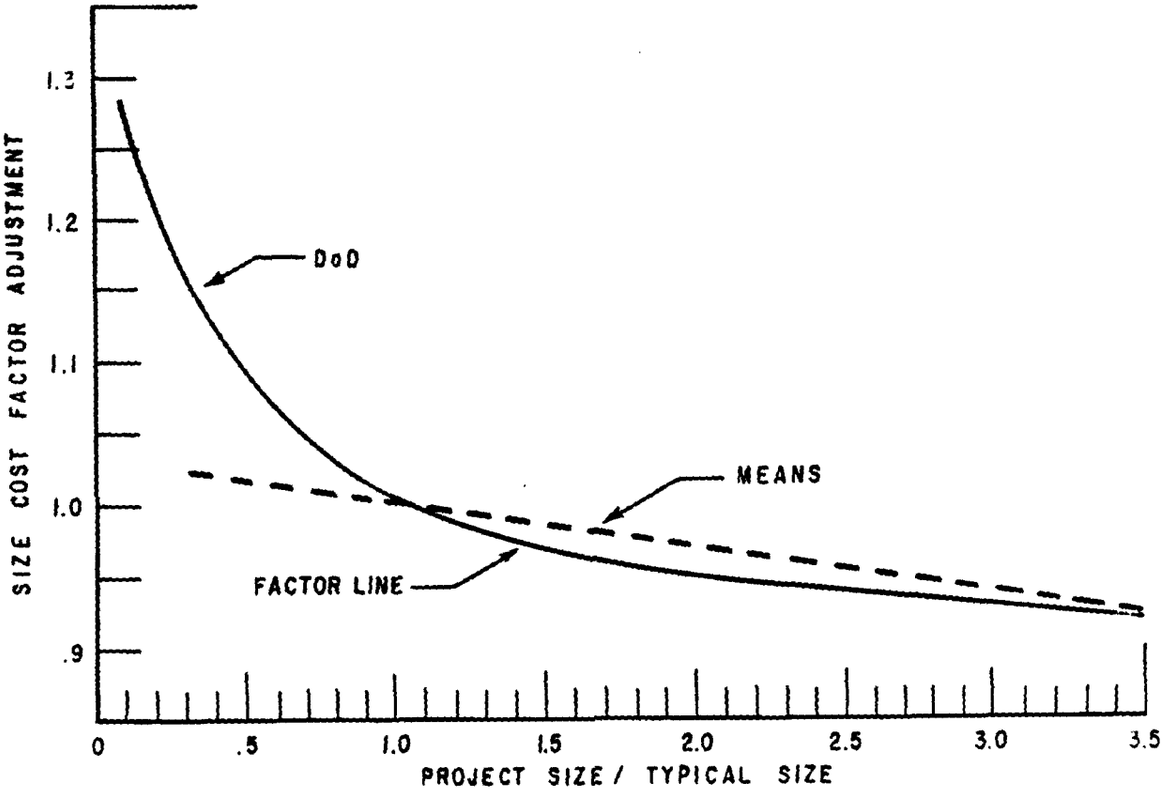
PROJECT SIZE

Economies of scale are widely recognized in the construction business. Construction cost per square foot declines as project size increases and other design criteria, project location, and the time period for construction remain the same. Figure A-1 displays both DoD and Means size adjustment factor lines. The DoD adjusts all unit costs to the costs for a typical size facility using values from the DoD curve in the figure. The Means size

[2]"Adjustments to the DoD Construction Material and Labor Indices," Memorandum from A.W. Fort, Commodore, CEC, USN, Director of Construction, August 10, 1984.

adjustment line is linear intersecting the DoD curve at 1.0 and 3.5 times typical size. The Means size factor is slightly higher than DoD between 1.0 and 3.5 and becomes significantly less when project size drops below the 1.0 point.

FIGURE A-1. SIZE/UNIT COST FACTOR ADJUSTMENT



A third source of the size adjustment factor is implicit in "Means Square Foot Costs," which contains estimated cost per square foot for commercial facilities in several size categories. These size adjustments differ for each facility type but are closer to the DoD size adjustment curve than the Means straight line adjustment when the project size is less than the typical size. Based on this comparison, we assume that the DoD size adjustment factor is accurate to within 2 percent (one standard deviation) over a range of 0.75 to

2.0 times typical project size. The DoD unit costs for the facilities we evaluated did not use size adjustments outside this range and was, therefore, not considered to be a factor in the study.

COMBINED EFFECTS

Standard deviations have been estimated at two percent for the inflation adjustment, seven percent for the location adjustment, and two percent for the size adjustment. Assuming these errors are independently randomly distributed,[3] the standard deviation for the combination of all three adjustments is 7.6 percent.[4] This potential source of estimating error is dominated by the uncertainty in the estimates of the location adjustment factor.

The number of projects in the data base, the standard deviation of unit costs expressed both in dollars and as a percent of average unit costs, and the minimum and maximum values for cost per square foot are also shown in Table 3-1. Those data indicate considerable variation about the average cost per square foot data. The lowest relative standard deviation figures are 21 and 23 percent of average unit costs for physical fitness training centers and barracks/dormitories, respectively. These facilities are typically designed to a higher degree of standardization than are vehicle maintenance shops, general-purpose warehouses, or child care centers, which have relative standard deviations equal to 47, 61, and 30 percent of average unit costs, respectively. A review of selected high-cost warehouses in the data base revealed that some were designed with computer rooms and administrative offices whereas others were designed for storage only. Variation in design

[3]The log-normal distribution is assumed.

[4]The standard deviation of the combination of three adjustment factors is not simply the sum of each individual standard deviation since an overestimate of one factor may be compensated by an underestimate in a second factor. The standard deviation of the adjustments combined is the square root of the sum of the individual factor variances.

criteria results in a data base with significantly different structures, which complicates the problem of making valid cost comparisons with commercial facilities.

Even after the data are adjusted for inflation, location, and size, highly standardized dormitories and fitness centers still show standard deviations in excess of 20 percent of unit costs (a common problem with construction cost data). When comparing these data to unit costs for commercial facilities, it is important to show whether the observed differences in average unit costs are statistically significant. We have included tests for statistical significance of the difference between military and commercial unit costs in the comparative analysis.

APPENDIX B

PRIVATE SECTOR CONSTRUCTION COST DATA

COST INFORMATION SOURCES

A critical part of the study involved obtaining accurate cost information that would be adequate for the comparison between the DoD unit costs and those in the private sector. Initially, we considered four sources for obtaining the needed cost information: LMI-conducted surveys, association data bases, commercial data bases, and government-maintained statistics. Each of these sources was investigated to determine whether any one or combination of sources would provide the needed information. In the investigation, we examined the size of the data base, the categorization of the elements, the consistency of the data, and the initial source of the information. These factors were considered for each potential source, and a combination of sources was selected.

Three of the four potential cost information sources were found to have serious shortcomings. Surveys were eliminated as a major information source because, inter alia, they would require a great deal of time and resources to obtain a reasonable sample size that would, in the best case, be only regional in scope. Furthermore, surveys were unlikely to provide us with a reasonable sample size of data in each of the six facility categories. Therefore, they were eliminated.

Twenty-eight national associations were contacted to determine whether they maintained cost information records that could be used. Only one association, the Association of University Architects (A.U.A.), maintained cost information that could potentially be used. We contacted members of the A.U.A. and, after examining the data base, determined that the A.U.A. had only

one classification of facilities that could be compared with a DoD category; its dormitory data could be compared with barracks data. Other categories, however, either had insufficient data points or were not comparable. Thus, that source was also eliminated. The only potential government sources of private sector construction costs found were the Current Construction Reports maintained by the Bureau of the Census. We found these reports to be of little value for our analysis since the cost information they contained was aggregated by categories, and cost ranges, averages, or other information on the data distribution could not be extracted. We also found that the source of the Census Bureau information was a large commercial data base maintained by Data Resources Incorporated.

The final source examined was commercial data bases. Two major commercial data bases serve most of the construction industry's needs. Large, well-structured data bases are maintained by the R.S. Means Company, Inc., and Data Resources, Inc. (DRI), the latter through the F.W. Dodge Company (like DRI, a subsidiary of McGraw-Hill, Inc.). Both of these data bases had categories that could readily be compared to the selected DoD facility types. These data bases are continually updated in terms of cost as well as new projects, and either could provide adequate information for comparison to the DoD unit costs.

Although commercial data bases could provide information for an adequate comparison with the DoD costs, they do not have a reference point that could be directly related to the DoD cost experiences. This problem was overcome by conducting a limited survey and developing a specific private sector example for each of the six facility types that would be representative of the design and construction criteria found in DoD projects. These specific examples in conjunction with the cost ranges and averages developed from commercial data bases would provide adequate information for comparison to the DoD unit costs.

A three-component approach was settled upon as providing the most useful information for a comparison. First, the R.S. Means data base would be used to generate a range and average of construction costs for each category. Second, cost information from F.W. Dodge would be sorted and culled in an effort to "fine tune" the data categories to make them represent, as closely as possible, the six selected DoD facility types; the F.W. Dodge information would also be sorted by owner giving a further breakdown of the costs. Third, the specific private sector examples would be superimposed on the two ranges to provide a reference point. We felt that cost ranges developed in this manner would provide a satisfactory framework for the comparison of DoD and private sector construction costs.

R.S. MEANS COST DATA BASE

The R.S. Means Company, Inc., is a 42-year old company actively engaged in construction cost publishing and consulting throughout North America. It is involved in many facets of the construction industry including both historical data reporting, forecasting, and estimating. Along with F.W. Dodge, the R.S. Means Company has long been an industry leader and, in some cases, the industry standard. Every year it produces 16 major construction cost publications that are widely used by the construction industry. Additionally, it provides six computer software services that cover various aspects of cost estimating and scheduling. We felt that any effort to establish construction costs for the private sector would have to include an examination of the information maintained in the Means completed project data base.

We found that Means maintains extensive data bases on materials, labor, and completed construction projects. We concentrated on the completed project data base as presented in the 1984 volumes of the Building Construction Cost

Data and the Means Square Foot Costs. The Means data base contains construction costs for more than 9500 projects. The average sample size for any category is 160 projects. New projects are added to the data base every year, and projects more than 10 years old are discarded. Costs are kept current by constantly adjusting them with the various Means construction cost indices. The costs in the data base reflect actual construction costs including contractor overhead and profit. They do not reflect, however, any architectural, engineering, or land costs nor is any effort made to eliminate data elements that may not reflect the norm of construction for any given project type. Thus, no indication is given as to whether projects whose unit costs are on the high side of the historical range are constructed to higher standards or simply reflect extraordinary site work or location costs. As a general rule, Means median costs do not include site work, while costs greater than the median may contain some unusual equipment and site work expenses. However, based upon discussions with R.S. Means personnel, this occurs infrequently and is not considered to have a significant impact on cost data.

We also discovered that private sector costs, either at the median or slightly above it, generally reflect the same types of specifications as DoD construction for the categories examined; on the other hand, private sector costs on the low end of the range are often built to much less-stringent specifications. Comparisons of data points from the low end of the range to DoD costs must be done carefully to ensure that like facilities are being compared.

Size variation is another factor that must be considered when comparing the two data bases. The square foot area for the Means category was not always equal to that for the DoD unit cost being compared. However, we found that the Means data were relatively insensitive to size variations. A project

could be tripled, and the cost adjustment would be only a 6 percent decrease. Likewise, a halving of the project size resulted in only a 1.5 percent increase in costs. Since that range would allow all Means categories to meet DoD size requirements, size was not considered important. We felt that after considering the various aspects of the Means data base and the DoD data base, a comparison between the two would be appropriate and useful.

The distribution of costs for the Means data base was assumed to be normal. Our examination of percentile data and medians for each facility category supported that assumption. We also discussed the assumption with R.S. Means personnel, who indicated that, based on their experience, this was a valid approach, and that any deviations from the normal would take the form of an extended "tail," which would not alter the basic shape of the distribution.

MEANS FACILITY COST RANGES

Wheeled Vehicle Maintenance Shops

The Means category that is most comparable to the DoD 30,000 square foot wheeled vehicle maintenance facilities is the commercial garage category, Code 2.029. That category contains facilities built to maintain and service light trucks and cars. The typical size is 9300 square feet, and the median cost for this type of facility is $44.11 per square foot with a standard deviation of $23.97 per square foot.

General-Purpose Warehouses

The Means category that is most comparable to the DoD 40,000 square foot general-purpose warehouses is the warehouse with office category, Code 2.069. That category includes general-purpose warehouses with a limited amount of office space. The typical size for this type of facility is 25,000 square feet, and the median cost is $31.57 per square foot with a standard deviation of $17.24 per square foot.

Barracks

The Means category that is most comparable to barracks is low-rise college dormitories, Code 2.013. That category represents construction of low-rise (1-3 story) college dormitories. The median cost for this type of facility is $64.46 per square foot with a standard deviation of $25.77 per square foot.

Fitness Centers

The Means category that is most comparable to the DoD 20,000 square foot fitness centers is gymnasiums, Code 2.031. That category includes all types of gymnasiums and associated facilities. As would be expected, the range for that category is very broad with construction varying from simple gymnasiums to complex fitness centers. The typical size for this type of facility is 19,200 square feet, and the median cost is $57.64 per square foot with a standard deviation of $27.91 per square foot.

Child Care Centers

The Means category that is most comparable to the DoD 8000 square foot child care centers is religious education centers, Code 2.052. Means, as well as Dodge and others, does not maintain costs for a child care center category. As a result, a surrogate from the existing categories had to be chosen. The two obvious choices are elementary schools and religious education centers. During the course of interviews with persons in the child care industry, we found that religious education facilities were very comparable to child care centers. In fact, many child care centers share religious education facilities, utilizing them when they are not required for religious purposes. The typical size of a religious education facility is 9000 square feet, and the median cost is $53.46 per square foot with a standard deviation of $18.39 per square foot.

Family Housing

The R.S. Means Company does not maintain data on residential housing costs.

DATA RESOURCES (F.W. DODGE) COST DATA BASE

Data Resources, Inc., is a subsidiary of McGraw-Hill, Inc., which provides integrated economic information in support of planning and decision-making for all segments of the construction industry. Numerous categories of construction information are maintained by McGraw-Hill subsidiaries and accessed through its construction analysis system (CAS). The construction cost data in CAS is provided by the F.W. Dodge Company, another McGraw-Hill subsidiary. F.W. Dodge has provided detailed construction activity information to the building industry and its suppliers for more than 85 years. Every year, the F.W. Dodge Company publishes three cost reference manuals and numerous publications on construction activity. It also provides three computerized cost estimating services that cover the various levels of construction planning. The amount of information available in the F.W. Dodge data base made it a prime source of private sector construction costs. The F.W. Dodge data, in conjunction with information from the R.S. Means Company, provides a good picture of historical construction costs.

The F.W. Dodge Company operates an extensive information-gathering network that it claims captures data on 99 percent of all new construction starts. The data base covers a period of 15 years and has close to one million data elements. New projects are continually added and older information is deleted through routine maintenance of the data base. The size and complexity of the data base make it possible to obtain cost information in virtually any format desired. For this study, a nationwide data class was selected from the DRI 1983 completed project data base for each of the

facilities under consideration. This nationwide data class was then sorted by size, age, and owner. The result was a sample of current, similar-sized facilities sorted by owner.

The costs included in the Dodge data elements are generally those for construction of the building only and exclude engineering, land, and other costs. Infrequently, data points contain site work expenses that are not normally included in DoD costs. Discussions with Dodge personnel indicated that the inclusion of some site work would not distort the comparison since the number and magnitude of the differences would be negligible. Projects in the lower quarter of the cost range would often be representative of lower quality and temporary construction, and their costs could not be logically compared with DoD costs. As with the Means data, comparisons of costs from this portion of the range with DoD unit cost factors has to be done carefully to ensure that like facilities are being contrasted. The problem of size comparability was lessened by initial size sortings performed on the Dodge information. The unit costs for the sorted samples were found to be changed very little by moderate size variations. In most cases, a project size could be tripled with only a five percent decrease in the unit cost. This degree of variation was well within the difference between the DoD and the Dodge average size.

The Dodge data base contains a full spectrum of construction costs, ranging from small, temporary facilities to large, permanent complexes. We felt that after sorting the data into appropriate size categories and recognizing those factors affecting the extremes of the ranges, a meaningful comparison between the Dodge cost data and the DoD unit cost factors was possible.

Most of the cost distributions for the categories examined were approxi-
ted by the normal distribution. The sophistication of the Dodge data base
abled us to obtain frequency unit cost distributions for each of the
tegories being discussed. In four of the six categories, the normal
stribution closely approximated the actual unit cost distribution. Only
hicle maintenance shop and child care center categories were significantly
fferent from the normal. In both cases, the cost distributions were skewed
the left. However, we felt that any error imposed by assuming these to be
rmally distributed would be negligible, and thus, for statistical purposes,
ıe normal distribution was used.

W. DODGE FACILITY COST RANGES

Wheeled Vehicle Maintenance Shops

The Dodge category that is most comparable to the DoD 30,000 square
ɔot wheeled vehicle maintenance shops is the truck service category,
ɔde 135. This category contains projects intended to be used for light and
ɜavy truck maintenance. A limited number of small buildings, such as tire
ıops, that are ancillary to the basic facility have a minor impact on the
ɤerage cost range. The typical size of this facility is 9900 square feet,
ıd the median cost is $36.23 per square foot with a standard deviation of
18.17 per square foot.

General-Purpose Warehouses

The Dodge category that is most comparable to the DoD 40,000 square
ɔot general-purpose warehouses i: warehouses, Code 003. This category is
ıde up of various types of warehouses with a large size variation, and
ıcludes some very high-cost facilities built to satisfy special requirements.
ıe typical size for this classification is 14,600 square feet, and the median
ɔst is $28.64 per square foot with a standard deviation of $10.46 per square
ɔot.

Barracks

The Dodge category that is most comparable to barracks is dormitories, Code 074. This category contains all types and sizes of dormitories, including multistory buildings. The typical size is 41,800 square feet which is comparable to the normal DoD size. The median cost is $67.04 per square foot with a standard deviation of $21.62 per square foot.

Fitness Centers

The Dodge categories that are most comparable to fitness centers is gym/fieldhouses, Codes 062 and 262. These classifications contains both school-owned and non-school-owned facilities. The typical sizes for these types of facilities are 15,500 square feet, which are comparable to the DoD category size. The median cost is $61.64 per square foot with a standard deviation of $23.12 per square foot.

Child Care Centers

The Dodge category that is most comparable to 8000 square foot child care centers is special schools, Code 074. Dodge does not maintain cost information on child care centers as a separate classification. Consequently, the parent category for child care centers, special schools, was used as a surrogate. Caution must be used when comparing DoD child care costs to this category. The Dodge classification includes numerous data points for facilities that are not similar to child care centers, and these additional points may tend to hide or distort the child care center information and make comparisons difficult. The typical size for this type of facility is 7100 square feet, and the median cost is $58.08 per square foot with a standard deviation of $18.28 per square foot.

LITY TYPE: Automotive Repair/Wheeled Vehicle Maintenance Shop

TION: Gaithersburg, Maryland

'S: $47.81/s.f. April 86 dollars Washington, D.C.
$44.27/s.f. April 86 dollars 144 City Average

)R SYSTEMS:

Exterior - Brick and block.

Interior - Block partitions, concrete floor, exposed ceiling in bays, drop ceiling in retail area, tile floor in retail/office area.

Structural - Load bearing block walls, steel roof trusses with intermediate pipe supports, steel girders, and steel roof deck.

Roof - Built up roof.

HVAC - Air conditioned with hot water ceiling mounted heating units.

Furnishings - Air compressor and distribution system, hydraulic lifts, and battery rooms included.

ERAL DESCRIPTION:

A brick and block open bay structure with a parts area and a small retail a. Interior finish details for the parts storage area and the retail/ ice area are a higher grade than those experienced in DoD construction. ting and air conditioning are connected to the main store's physical plant. adjustment to the square foot unit costs was made to correct for this.) owner is a large retailer who constructs numerous facilities of this type. overhead cranes or supporting structures were present. Architect and ineer fees are not included, nor are land costs.

APPENDIX D

PRIVATE SECTOR EXAMPLE DATA SHEETS

TABLE C-6. COST RANGE COMPARISONS BY SOURCE
CHILD CARE CENTERS

All Costs Are April 1986 Dollars Per Square Foot

	DOD	MEANS[2]	F.W. DODGE/ DRI[3]
SIZE RANGE (s.f.):			
High	22,128	12,000	200,000
Low	4,570	6,000	300
Typical	8,000	9,000	7,100
COST RANGE:			
High	$149.62	$90.20	$185.61
Low	50.34	35.42	27.60
Mean	79.90	--	58.06
Stnd. Dev.	24.16	18.39	18.28
Median	76.16	53.46	58.08[1]
Private Sector Example	$72.00		

[1]Median value assumed to be equal to the mean.

[2]The Means category used for this comparison was religious education centers.

[3]The F.W. Dodge/DRI category used for this comparison was special schools.

TABLE C-5. COST AND SIZE COMPARISON BY SOURCE
FAMILY HOUSING

All Costs are April 1986 Dollars Per Square Foot

	DOD	MEANS	F.W. DODGE/ DRI
SIZE RANGE (s.f.):			
High		--	6,900
Low		--	800
Typical		--	3,800
COST RANGE:			
High		--	$106.14
Low		--	16.10
Mean	$46.00	--	41.74
Stnd. Dev.		--	13.92
Median		--	41.74[1]
Private Sector Example	$53.19		

[1]Median value assumed to be equal to the mean.

TABLE C-4. COST RANGE COMPARISONS BY SOURCE
BARRACKS/DORMITORIES

All Costs Are April 1986 Dollars Per Square Foot

	DOD	MEANS	F.W. DODGE/ DRI
SIZE RANGE (s.f.):			
High	240,480	41,000	276,600
Low	4,002	11,600	10,600
Typical	94,000[2]	19,200	41,800
COST RANGE:			
High	$92.84	$114.40	$164.34
Low	30.40	37.40	28.75
Mean	54.88	--	67.04
Stnd. Dev.	12.60	27.91	21.62
Median	55.83	64.46	67.04[1]
Private Sector Example	$64.07		

[1]Median value assumed to be equal to the mean.

[2]DoD unit costs do not have a published typical size.

TABLE C-3. COST RANGE COMPARISONS BY SOURCE
FITNESS CENTERS

All Costs Are April 1986 Dollars Per Square Foot

	DOD	MEANS	F.W. DODGE/ DRI
SIZE RANGE (s.f.):			
High	69,598	41,000	132,000
Low	1,800	11,600	1,600
Typical	20,000	19,200	15,500
COST RANGE:			
High	$115.34	$114.40	$162.15
Low	49.46	37.40	24.61
Mean	70.06	--	61.64
Stnd. Dev.	14.51	27.91	23.12
Median	67.65	57.64	61.64[1]
Private Sector			
Example	$ 93.05		

[1]Median value assumed to be equal to the mean.

TABLE C-2. COST RANGE COMPARISONS BY SOURCE
GENERAL PURPOSE WAREHOUSES

All Costs Are April 1986 Dollars Per Square Foot

	DOD	MEANS	F.W. DODGE/ DRI	ADJUSTED[2] DOD
SIZE RANGE (s.f.):				
High	62,953	72,000	629,000	60,000
Low	37,848	8,000	1,000	38,934
Typical	40,000	25,000	14,600	40,000
COST RANGE:				
High	$87.27	$61.60	$103.50	$37.57
Low	15.82	9.90	3.68	15.82
Mean	38.18	--	28.64	24.90
Stnd. Dev.	23.16	17.24	10.46	7.88
Median	27.36	31.57	28.64[1]	24.84
Private Sector Example	$22.00			

[1]Median value assumed to be equal to the mean.

[2]Nonrepresentative data points removed.

TABLE C-1. COST AND SIZE COMPARISONS BY SOURCE
WHEELED VEHICLE MAINTENANCE SHOPS

All Costs Are April 1986 Dollars Per Square Foot

	DOD	MEANS	F.W. DODGE/ DRI	ADJUSTED[2] DOD
SIZE RANGE (s.f.):				
High	218,200	13,600	108,000	51,572
Low	27,301	5,000	1,300	27,301
Typical	30,000	9,300	9,900	30,000
COST RANGE:				
High	$138.63	$85.80	$134.20	$97.24
Low	23.26	22.00	12.65	23.26
Mean	69.56	--	36.23	55.95
Stnd. Dev.	32.48	23.97	18.17	16.85
Median	54.22	44.11	36.23[1]	53.09
Private Sector Example	$44.27			

[1]Median value assumed to be equal to the mean.

[2]Nonrepresentative data points removed.

APPENDIX C

COST AND SIZE NUMERICAL COMPARISONS BY SOURCE

differences requiring cost adjustments in this example. The unit cost for this facility is $53.19 per square foot. Additional information on this example is presented in Appendix D.

Fitness Centers

The facility used for this example was a 70,000 square foot brick and block building located in Washington, D.C. The quality of the construction reflects the same type of design criteria and specifications utilized in DoD construction. The structure is a multipurpose athletic facility that includes racquetball courts, gymnasium, weight rooms, locker rooms, and offices. A major difference exists in that one wing of the private center houses an indoor swimming pool. However, the costs for this difference are easily excluded since it is a separate bid item in the contract. Additionally, some extraordinary site work costs for a large fill on the site are also deleted from the analysis. The adjusted unit cost for this facility is $93.05 per square foot. Additional information on this example is presented in Appendix D.

Child Care Centers

The example used for child care centers was a 6000 square foot wood frame structure located in Burke, Virginia. The structure is well built, with materials and workmanship closely paralleling DoD standards. The facility contains all the characteristics of a DoD facility, including a commercial kitchen. The structure has vertical cedar siding in lieu of a masonry exterior resulting in a $4.00 to $7.00 per square foot savings when compared to masonry. The unit cost for this facility is $72.00 per square foot. Additional information on this example is presented in Appendix D.

Family Housing

The private family housing example selected was a 3270 square foot (1635 square foot/unit) wood frame duplex located in Arlington, Virginia. The duplex is built to local code requirements. Workmanship and materials are comparable to those found in DoD housing units. There are no significant

cost for this facility is $44.27 per square foot. Additional information on this example is presented in Appendix D.

General Purpose Warehouse

The example used for general purpose warehouses was a 48,000 square foot brick and block, steel frame structure located in Fairfax County, Virginia. The materials and quality of work in this building are slightly higher than those normally experienced in a similar DoD facility because the owner wished to construct a multiapplication building that could be converted to a research and development facility if the demand for such use materialized. The major difference between this structure and normal warehouse construction is the large percentage of window area in this project (window area is normally more expensive than brick and block construction). No adjustment was made, however, for the additional glass area since our investigation revealed that many DoD warehouses have a higher percentage of office space than would be expected in a storage facility, and thus contain more windows than a normal private sector warehouse. The unit cost for this facility is $22.00 per square foot. Additional information on this example is presented in Appendix D.

Barracks/Dormitories

The facility used for this example was a 90,000 square foot brick and block structure located in Washington, D.C. The materials and workmanship for this building are very comparable to those encountered in DoD construction. The building design is similar to current housing policy with two double-occupancy rooms sharing a common area. The only significant difference from DoD criteria is the use of metal stud and drywall interior walls as opposed to DoD-utilized masonry partitions. The unit cost for this facility is $64.07 per square foot. Additional information on this example is presented in Appendix D.

and they provide a sense for the point in any range at which construction criteria generally equal those of the DoD.

The specific private sector examples were initially selected on a random basis. We visited construction permit offices for the District of Columbia and surrounding counties to generate a list of potential examples in each facility category, and then contacted owners and builders to determine whether the projects were representative of DoD construction criteria and whether the owners were willing to provide cost information on the projects. After determining the most likely candidates for the study, we interviewed the owners and builders and visited the facilities. During these interviews, we determined whether the building standards were comparable with DoD standards. If they were, cost information was obtained. The cost data were then adjusted to the 144-city average and escalated to April 1986 prices. A data sheet developed for each specific example contains information on costs, major building systems, location, and a general description of the project. The costs for the specific examples were then superimposed on the cost ranges previously developed. A general discussion of each specific example is presented here with additional information in the data sheets in Appendix C.

Wheeled Vehicle Maintenance

The facility used for this example was a 30,000 square foot brick and block structure located in Gaithersburg, Maryland. The materials and workmanship in this structure were very comparable to DoD facilities, although some differences in the design of the structure were noted. The primary differences were that the private sector structure has no windows, is located in a small retail area, has a higher quality of finish in the office and parts area, and shares mechanical systems with a parent facility. An adjustment was made to the unit cost to correct for these differences. The adjusted unit

Family Housing

The Dodge category that is most comparable to family housing units is three- and four-unit apartments, Code 075. This classification includes small, low-rise apartment buildings in a size range that is comparable with DoD standards. The typical size is 3800 square feet or about 1200 square feet per unit. This size is comparable with the normal DoD housing unit size. The median cost is $41.74 per square foot with a standard deviation of $13.92 per square foot.

PRIVATE SECTOR SPECIFIC EXAMPLES

Selection of Examples

As more information on private sector construction costs was gathered, it became apparent that an additional reference point would make the comparison of the DoD and private sector costs more meaningful. Since private sector cost ranges include many data points that are not representative of DoD construction, comparison of DoD mean costs to private sector median or mean costs is difficult, particularly in those categories in which a significant number of the data points fall in the low end of the range. To eliminate this problem, we developed a specific private sector example for each facility category as an additional reference point. These specific examples also serve to verify that construction in certain areas of the private sector ranges used the same criteria as DoD facilities.

This type of approach has limitations. The examples are not selected to represent a typical facility in any category, nor should they be construed as some type of mean or median. They simply represent a single, randomly selected data point that falls within the cost range for that facility category. Their value is that they give some definition to what otherwise is a continuum representing a wide range of construction criteria,

FACILITY TYPE: General Purpose Warehouse

LOCATION: Fairfax, Virginia

COSTS: $23.76/s.f. April 86 dollars Washington, D.C.
$22.00/s.f. April 86 dollars 144 City Average

MAJOR SYSTEMS:

Exterior - Brick and block curtain walls with glass walls in some areas.

Interior - Exposed ceiling and block wall. No finished office space included in the cost. Concrete slab on grade floor.

Structural - Steel frame with steel roof trusses. Walls are non-load bearing masonry and glass curtain walls.

Roof - Membrane roof.

HVAC - Hot water heat (air conditioning not in basic costs).

Furnishings - None included.

GENERAL DESCRIPTION:

A steel frame structure with masonry and glass curtain walls. The masonry is brick and block while the glass units are standard window walls. The completed facility is intended to be a multi-application building and will be altered based upon the tenants'/buyer's needs. The amount of glass in the exterior walls is greater than that normally encountered in a DoD structure resulting in higher exterior wall costs (glass costs approximately $4.50/s.f. of wall area more than brick and block construction). No land costs or architectural and engineering fees were included. No extraordinary site work was required.

FACILITY TYPE: Dormitory/Barracks

LOCATION: Washington, D.C.

COSTS: $69.20/s.f. April 86 dollars Washington, D.C.
$64.07/s.f. April 86 dollars 144 City Average

MAJOR SYSTEMS:

Exterior - Brick and block.

Interior - Metal studs with dry wall and standard architectural details.

Structural - Steel frame and concrete floor.

Roof - Inverted built-up roof.

HVAC - Gas air conditioning and heating units in each room.

Furnishings - None included.

GENERAL DESCRIPTION:

A steel frame, brick and block, four-story building. The interior is partitioned with metal studs and drywall (less costly than DoD masonry partitions) into 90 units consisting of two two-person rooms with a common area shared by both rooms. No extraordinary site work or construction problems were encountered. The owner stated that the project was brought in under budgeted and estimated costs. Architect and engineer fees are not included, nor are land costs.

FACILITY TYPE: Athletic Facility/Fitness Center

LOCATION: Washington, D.C.

COSTS: $100.49/s.f. April 86 dollars Washington, D.C.
$ 93.05/s.f. April 86 dollars 144 City Average

MAJOR SYSTEMS:

Exterior - Brick and block with parged concrete foundation walls.

Interior - Load bearing block partitions, carpet and synthetic membrane flooring, a drop ceiling, and standard architectural details.

Structural - Load bearing block walls, pre-cast concrete roof decks over offices, bar joists with light-weight concrete over gym, and poured-in-place concrete over the locker rooms.

Roof - Single-ply membrane roof.

HVAC - Air conditioning for all areas except the gymnasium and pool. Chilled water cooling and hot water heat (gas and/or oil fired).

Furnishings - Backboards and bleachers were included; however, small equipment such as weights was not included.

GENERAL DESCRIPTION:

A concrete and masonry multipurpose athletic facility consisting of a gymnasium, racquetball courts, weight rooms, locker rooms, offices, and multi-purpose rooms. The design included a swimming pool in one wing which was deleted from the analysis. Additional costs related to extraordinary site work were also factored out, as were architectural and engineering fees.

FACILITY TYPE: Child Care Center

LOCATION: Burk, VA

COSTS: $72.00/s.f. April 86 dollars Washington, D.C.
$66.67/s.f. April 86 dollars 144 City Average

MAJOR SYSTEMS:

Exterior - Vertical cedar siding.

Interior - Gypsum board and stud partitions, gypsum board ceilings, flourescent lights, tile and carpet floors, and two large restrooms.

Structural - Wood frame with pitched roof trusses and slab on grade floor.

Roof - Standard shingle roof.

HVAC - Multi-zoned electric air conditioning and heating via two air-handling units and ducts. Sprinkler system throughout.

Furnishings - Furnished commercial kitchen included. Furniture is not included.

GENERAL DESCRIPTION:

Standard wood frame construction building. Partition doors are metal with metal frames. The facility contains a commercial kitchen, sprinkler system, and a large number of plumbing fixtures, e.g. sinks, fountains, etc. The exterior of the building is wood siding which is $4 - $7/s.f. less expensive than brick. No land or engineering costs are included. No extraordinary site work required.

FACILITY TYPE: Two Bedroom Duplex/Family Housing

LOCATION: Arlington, Virginia

COSTS: $57.46/s.f. April 86 dollars Washington, D.C.
$53.19/s.f. April 86 dollars 144 City Average

MAJOR SYSTEMS:

Exterior - Aluminum siding and gutters.

Interior - Gypsum board and stud partitions, carpet and synthetic flooring, gypsum board ceilings, and 1½ baths.

Structural - Two-story wood frame construction.

Roof - Standard shingle roof.

HVAC - Electric heat and air conditioning.

Furnishings - Oven, refrigerator, dishwasher, and garbage disposal included.

GENERAL DESCRIPTION:

Standard wood frame construction of a two bedroom, two-story duplex with basement. Materials meet minimum code requirements. No extraordinary site or utility work required. Land costs are not included, nor are architectural fees.

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This study compares construction costs for six DoD facility categories with those experienced by other government agencies and the private sector. Categories chosen were warehouses, fitness centers, maintenance centers, family housing, barracks, and child care centers. The conclusion was that costs are basically in line with those experienced by other owners.

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